

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This Amendment is in response to the Office Action dated January 13, 2004. Appreciation is expressed to the Examiner for the indication of allowable subject matter in claims 4 and 5.

By the present Amendment, claim 4 has been amended to incorporate the subject matter of claim 1. In light of the indication of allowable subject matter in claim 4 if rewritten into independent form, reconsideration and allowance of claim 4 and its dependent claim 5 is respectfully requested.

Also by the present Amendment, claims 1-3 and 6 have been cancelled without prejudice to the Applicants' right to proceed with filing a Continuation application directed to the subject matter of these cancelled claims. Claim 7 has been amended to clarify the invention, and new dependent claims 12-19 have been added to further define the invention.

Briefly, a feature of the present invention defined by both of the pending independent claims 7 and 8 pertains to the design of a fuel injector to provide separate fuel sprays having different penetrations in different directions from the fuel injector. In addition, as defined in claim 8 and its dependent claims, the present invention includes the combination of such a fuel injector to make penetration different in different directions with an intake airflow control that also has an effect on penetration (as defined in new claims 17-19).

More specifically, referring to Figs. 4-10, a fuel injector is shown which includes swirl plates (such as 14 shown in Figs. 5, 6b and 10) which can create two

separate fuel sprays in two different directions having different penetration depths (noting that the use of two sprays is solely for purposes of example, with a greater number being possible). As discussed on page 26, line 12 et seq., one way to accomplish the different penetration is as follows:

“In order to make the penetration different between the two sprays 150 and 151, as shown in FIG. 3, the intensities of the swirled fuel produced by the swirl plate 14 are made different from each other. In detail, this can be attained by adjusting the sectional area of the passage or the amount of offset of the offset passage 14b. The penetration becomes strong when the offset amount is decreased, and the penetration becomes weak when the passage sectional area is decreased.”

As discussed on page 30, line 40 et seq., another way to control penetration depth is shown in the non-elected Fig. 11 (as defined by non-elected claim 11 which depends on generic claim 8) by providing separate fuel sprays by providing two different sets of small holes 42. For one of the sprays, a different number of the small holes 42 is used than the number of small holes 42 used for the other spray.

In addition to the use of the construction of the fuel injection valve for providing different sprays with different penetration depths, Fig. 3 shows another feature of the present invention that can also have an effect on the penetration depths. Specifically, as shown in Fig. 3, an intake airflow control device 147 is provided which creates a strong airflow 148 adjacent one of the fuel injection sprays and a relatively weak airflow 149 adjacent the other fuel injection sprays. As discussed on page 17, line 1 et seq. of the specification:

“A well-atomized hollow spray having a weak penetration is formed in the high speed intake airflow 148 side of the intake passage 146, and a hollow spray having a strong penetration is formed in the low speed intake airflow 149 side. As described above, by optimizing the airflow and the spray form, the transport lag of the fuel spray is

solved, and a quality of the mixed gas (stratification of the mixed gas) produced in the combustion chamber 142 is improved to stabilize the combustion."

As such, the present invention provides two separate arrangements for controlling the degree of penetration of two different fuel sprays (or more) to optimize combustion.

Reconsideration and allowance of claim 7 over the cited reference to Okamoto (USP 6,216,665) is respectfully requested. Claim 7 has been amended to clearly define at least first and second fuel injection holes that generate two separate sprays in two different directions, with the penetration of the spray from one of the holes being different than the penetration from the other of the holes.

In the reference to Okamoto, a single hole is provided that generates a single spray having two different penetrations within the same spray. This combined spray with a central portion and peripheral portions is clearly shown in Figs. 7A and 7B of Okamoto, and is discussed, for example, on column 16, line 39 et seq. as follows:

"In other words, the fuel spray structure has three pattern spray components which are a straight pattern fuel spray component a left radial pattern spray component and a right radial pattern fuel spray component. The straight pattern fuel spray component has a D1 direction component and directs for the lower portion, the left radial pattern fuel spray component has D2 direction component and directs for the left radial portion, and the right radial pattern fuel spray component has D3 direction component and directs for the right radial portion. By uniting the straight pattern fuel spray component, the left radial pattern fuel spray component and the right radial pattern fuel spray component, the comparative solid cone fuel spray structure according to the present invention is formed."

Thus, although claims 1-3 of the Okamoto patent define two sprays, in actuality they are really just components of a single united spray, as clearly defined in column 16.

Therefore, this is a very different arrangement from the truly separate sprays injected respectively from separate first and second fuel injection holes, as defined in the amended claim 7. Therefore, reconsideration and allowance of claim 7 over Okamoto is respectfully requested.

Reconsideration and allowance of the new dependent claims 12 and 13, each dependent on claim 7, is also respectfully requested. Claim 12 details features regarding means adjacent the first and second holes for making the intensity of the fuel spray different from the first and second fuel injection holes. Claim 13 details this by specifying that this means comprises a swirl plate to provide different swirl intensities for the sprays, as discussed on page 26, line 12 et seq. The Okamoto reference completely lacks any suggestions of such arrangements. Accordingly, reconsideration and allowance of these new dependent claims 12 and 13 over Okamoto is also respectfully requested.

Reconsideration and allowance of independent claim 8 is also respectfully requested. Claim 8 defines a combination of an intake airflow control device to control the airflow inside an intake pipe operating in conjunction with a fuel injection valve downstream of the airflow control device, wherein the fuel injection valve injects fuel in two different directions and includes means for making the penetration different in these two different directions. As such, it is clearly defined that the penetration of the fuel sprays is different in different directions.

In the reference to Matsumoto (USP 5,769,060), on the other hand, although there are apparently plural sprays, a careful reading shows that the penetration depth of each of these sprays is the same. More specifically, referring to Figs. 26 and 27 (referred to in the Office Action as well), each of the individual sprays has an

injection arc shown by the numeral 303. These individual sprays are then combined into a single spray having an arc 304. This is clearly defined by column 14, line 55 et seq. which states:

“It should be noted that the fuel injector 78 of this embodiment is of the duel-nozzle type. Each nozzle has a spray pattern, indicated by the arc 303 in Fig. 26, so that the combined spray pattern of the two nozzles is greater than that of a single nozzle, as indicated by the arc 304.

As such, unlike the present invention which actually provides sprays having different penetrations in different directions, Matsumoto provides sprays having the same penetration into a single stronger spray having greater penetration than any one spray. Therefore, reconsideration and allowance of independent claim 8, clearly defining the generation of separate sprays having different penetrations in different directions, is respectfully requested.

Reconsideration and allowance of newly submitted dependent claims 14-19 is also respectfully requested, noting that all of these claims are dependent either directly or indirectly from claim 8. Claim 14 adds the feature from claim 7 of the first and second fuel injection holes to provide the fuel sprays with different penetrations. Claims 15 and 16 provide the same features discussed above regarding claims 12 and 13 concerning the control of the fuel intensity and, more specifically, the use of a swirl plate to provide different swirl intensities. New dependent claims 17 to 19 specifically define the combination of the fuel injection arrangement to generate the different penetrations with the airflow control device (such as shown by the numeral 147 in Fig. 3). As discussed above, this can have a weakening effect on the penetration of one of the sprays relative to the penetration of the other spray, as

clearly set forth in dependent claims 17-19. Therefore, reconsideration and allowance of these new dependent claims 14-19 is also respectfully requested.

Reconsideration and allowance of the originally submitted dependent claims 9-11 is also respectfully requested. Regarding this, it is noted that claim 8 has been designated as a generic claim in the October 3, 2003 Office Action. Also, claim 8 has not been amended by the present Amendment. As such, upon the allowance of claim 8, allowance of the dependent claims 9-11 is respectfully requested based upon the generic status of their parent claim 8.

For the reasons set forth above, reconsideration and allowance of claims 4, 5 and 7-19 is respectfully requested.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of

Application No.: 09/943,500

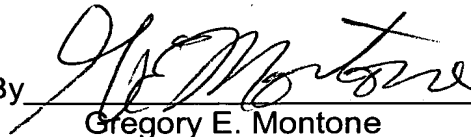
Docket No.: 503.40576X00

this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 503.40576X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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